PRELIMINARY
FINANCIAL AND ECONOMIC ANALYSIS
OF
STORAGE ALTERNATIVES
IN THE
WILLOW CREEK BASIN

November 18, 1985

SYNOPSIS

A preliminary (farm) financial, (public) economic, and (public) socio-economic analysis was conducted which looked at four storage alternatives in the Willow Creek Basin:

Site 1 - Claresholm

Site 2 - Pine Coulee

Site 3 - Lane Creek

Site 4 - Junction

The summary results are provided in accompanying Table 1-1.

The farm financial results generally indicate that if off-farm system costs (i.e., the capital costs of delivery systems) qualify for a 50 percent subsidy, and a 12 percent interest rate is appropriate, then, *in general*, any of these proposed irrigation development schemes should be a financially feasible proposition. These results, however, are very tentative since it was simply assumed throughout that all potentially irrigable lands would be equally profitable to irrigate. (As per SSRBPP analysis, Agroclimatic Zone C.) Thus, the slight variation in the respective financial B/C ratios indicated here is due *solely* to delivery cost differences between options. That is, in general, the larger the proposed scheme, the higher the *average* per unit delivery cost and, hence, the lower the B/C ratio. The rankings are, therefore, not very meaningful. The range is only 1.46 to 1.53 and this is little more than the margin of error which might be expected at this level of analysis.

The preliminary economic analysis (where the interest rate = 7%/annum) is somewhat more discriminating. The worst purely economic choice (or socio-economic choice) would appear to be the Junction Site.

Table 1-1

THE FINANCIAL, ECONOMIC, AND SOCIO-ECONOMIC FEASIBILITY OF WATER DEVELOPMENT ALTERNATIVES IN THE WILLOW CREEK SYSTEM, ALBERTA

Proposed Reservoir Site	FARM FINANCIAL ANALYSIS*		ECONOMIC ANALYSIS***			SOCIO-ECONOMIC ANALYSIS****		
	B/C Ratios	Rank**	B/C Ratios	NPV ($M)	Rank**	B/C Ratios	NPV ($M)	Rank**
Site 1 (Claresholm)	1.53	①	0.59	(6.7)	1	1.03	1.2	②
Site 2 (Pine Coulee)	1.50	③	0.56	(21.1)	3	0.98	(0.9)	3
Site 3 (Lane Creek)	1.52	②	0.58	(17.4)	2	1.04	1.7	①
Site 4 (Junction)	1.46	④	0.43	(39.8)	4	0.77	(15.9)	4

*Discount rate = 12%.

**Based on Benefit-Cost ratios. Circled rankings indicate feasibility.

***Only using efficient resource allocation criteria. Discount rate = 7%.

****Also considers "spin-offs'; particularly relevant to satisfy regional development objectives.

Unfortunately, the analysis is not refined enough (at least not yet) to be able to rank Sites 1, 2 and 3. Given our margin of error, these are, from an economic and socio-economic perspective at least, essentially the same.

Most importantly, however, from a purely economic perspective *none* of the four sites here considered appear to be a feasible investment opportunity. All of the economic B/C ratios are far below unity. This implies that given the estimated costs and various other parameters related to Sites 1, 2 and 3, these could *only* be rationalized (justified) at this time with reference to regional development priorities, i.e., local spin-offs.

Additional analysis is on-going.

Accompanying notes clarify what basic parameters were employed in this analysis and precisely how the various simulations were conducted. The four socio-economic simulations are also appended.

METHODOLOGY AND BASIC PARAMETERS

METHODOLOGY

A discounted financial cash flow analysis has been conducted assuming the following parameters are appropriate:

Time Frame:	30 years
Discount Rate:	12 percent/annum
Price Level:	Constant $ 1984/85

This on-farm analysis only compares on-farm irrigation development costs and 50 percent of the capital cost of corresponding delivery system development (and 100 percent of subsequent O & M for both) against the projected net revenue stream from crop/livestock production.

The discounted socio-economic cash-flow analysis conducted parallels the financial analysis, with four major exceptions:

1. The use of long-term prices (versus 1984/85 prices) and the use of cost-of-production estimates exclusive of property taxes. (Not adjusted in these preliminary simulations.)
2. A discount rate of 7 percent per annum (versus 12 percent per annum).
3. Consideration of storage and other off-farm development costs and benefits. And
4. Optional consideration of indirect (or spin-off/ secondary) benefits and costs.

The decision-making criteria employed (B/C ratios and NPV's)are identical.

We refer to the analysis which does not consider spin-offs as being a purely *economic analysis*; the analysis which does consider spin-offs (using a multiplier of 1.781)[1] as being a *socio-economic analysis*.

BASIC PARAMETERS[2]

Description of Potential Reservoirs

The parameters which relate to each potential storage option are indicated in accompanying Table 2-1.

The total incremental irrigated acreage indicated in Table 2-1 is the basis for almost all of the calculations implicit in each simulation. This acreage is expected to be developed fully over a 7-year period, beginning in Year 3. To reflect a quick start-up after a two year instruction period, however, these estimates are effectively pro-rated over 9 years but applied over 7 years. That is, approximately 33-44-55-66-77-88-100 percent over Years 3-9 respectively.

The estimated capital cost of these various storage sites is also indicated in Table 2-1. This is expected to be incurred as follows:

Year 1: 40%

Year 2: 60%

Operation and maintenance costs are anticipated to amount to 2 percent of the original capital cost/annum, beginning in Year 3.

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[1]See especially: Alberta Treasury/Bureau of Statistics, *Economic Multipliers for Alberta Industries and Commodities*, Edmonton, March 1984.

[2]Also see the notes which accompany simulation A-1.

Table 2.1

DESCRIPTION OF POTENTIAL RESERVOIRS - WILLOW CREEK BASIN

Proposed Reservoir Site	Reservoir Capacity (acre ft.)	Additional Potential Irrigation (acres)	Capital Cost ($ 1985)
Site 1 (Claresholm)	32,400	18,700	24,000,000
Site 2 (Pine Coulee)	40,745	21,333	29,500,000
Site 3 (Lane Creek)	47,800	20,000	25,000,000
Site 4 (Junction)	60,000	25,000	45,000,000

Delivery System Costs

Delivery system costs are largely a function of the distance and elevation the water must be transported. The acreages which could be irrigated are estimated to be as follows:[1]

Adjacent = 5,200 acres
0-0.8 km = 6,700 acres
0.8-1.6 km = 8,400 acres
1.6-3.2 km = 5,700 acres

At each distance, various capital and operating costs are anticipated:

Distance	Capital Cost/Acre	O & M/Acre/Year
Adjacent	-	-
0-0.8 km	$128	$ 4.28
0.8-1.6 km	268	7.68
1.6-3.2 km	448	11.48

Capital costs/acre have also been estimated from data prepared by Alberta Agriculture.[2] These costs would begin in Year 3.

Annual operating costs were calculated as an incremental cost vis-a-vis adjacent lands.[3] Maintenance costs are estimated to amount to 1 percent

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[1] Alberta Agriculture/Project Planning Branch, *Irrigation Feasibility in the Willow Creek Basin*, Lethbridge, August 1985.

[2] *Ibid.*

[3] *Ibid.*

of incremental capital costs. (Vis-a-vis adjacent lands.[1]) These are pro-rated according to the cumulative acreage under irrigation.

On-Farm Irrigation Costs

Again, this involves both a capital cost and an O & M cost. The estimated capital cost is $452/acre.[2]

Annual operating costs are expected to amount to some $23 per acre/year,[3] beginning in Year 3. Related maintenance costs are estimated at 1 percent of increment capital costs. Thus, O & M/year = $27.52/acre, again pro-rated according to the cumulative acreage under irrigation.[4]

On-Farm Irrigation Benefits

In this preliminary analysis (only), these are assumed to be typical of Agroclimatic Zone C for *all* of the storage options here considered. That is:[5]

Crop Incremental Net Value Added	= $ 59.89/acre/year
Livestock Incremental Net Value Added	= $ 76.49/acre/year
TOTAL	$136.38/acre/year

These projected benefits are also pro-rated according to the cumulative acreage under irrigation, beginning in Year 3.

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[1]Also see: MAA, *Economic and Financial Analysis of Clear Lake Irrigation Development*, Alberta Environment, December 1984, pp. 18-19.

[2]Alberta Agriculture, *op. cit.*

[3]Ibid.

[4]Also see:MAA, *op. cit.*

[5]Strong Hall/MAA, *South Saskatchewan Planning Program, Part II*, Alberta Environment, Calgary, July 1983.

Other Costs and Benefits

For the respective options, these are estimated to amount to the following:

Site 1: Potential benefits to the Claresholm water supply and related pumping costs; expected to amount to $25,000 per annum during Years 3-30.

Site 2: As Site 1, plus potential benefits to the Willow Creek Provincial Park, including possible fish habitat enhancement (reservoir and downstream). Estimated to amount to $50,000/year during Years 3-30.

Site 4: Potential negative impacts (costs) on the Willow Creek Provincial Park, roads, and fisheries. Expected to amount to $1M per year in Years 1-2 respectively. 2

Indirect Benefits

As noted above, these spin-offs are also considered such that we can generate a socio-economic analysis. The multiplier employed = 1.781. (See above.)

SIMULATIONS

(SOCIO-ECONOMIC)

Table A-1

BASIC ECONOMIC ANALYSIS – WILLOW CREEK – SITE 1 RESERVOIR (CLARESHOLM)[a]

($,000 1984/85)

Irrigated Area		INCREMENTAL COSTS										INCREMENTAL BENEFITS					
		Reservoir		Canal/Other		Delivery		On-Farm		TOTAL		Direct			Indirect	TOTAL	
Quarters	Acres	Capital	O&M	Capital	O&M	Capital	O&M	Capital	O&M	$'85	Dis.[b]	Crops	Livestock	Other		$'85	Dis.[b]
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
-	-	9,600	-	-	-	-	-	-	-	9,600	8,972	-	-	-	-	-	-
-	-	14,400	-	-	-	-	-	-	-	14,400	12,577	-	-	-	-	-	-
47	6,240	-	480	-	-	133	4	2820	172	3,609	2,946	374	477	25	665	1,541	1,258
63	8320	-	480	-	-	246	13	940	229	1,928	1,471	498	636	25	886	2,045	1,540
79	10,400	-	480	-	-	266	22	940	286	1,994	1,422	623	796	25	1,127	2,570	1,832
95	12,480	-	480	-	-	347	33	940	343	2,143	1,428	747	955	25	1,329	3,056	2,036
110	14,560	-	480	-	-	557	49	940	401	2,427	1,511	872	1,114	25	1,551	3,562	2,218
126	16640	-	480	-	-	557	65	940	458	2,500	1,455	997	1,273	25	1,775	4,068	2,368
142	18,720	-	480	-	-	557	81	940	515	2,573	1,399	1,121	1,432	25	1,994	4,572	2,487
142	18,720	-	480	-	-	-	81	-	515	1,076	6,382	1,121	1,432	25	1,994	4,572	24,996

39,523 (c)

40,705 (d)

...ent on
...ve

...stream reservoir; 32,400 acre feet. Effective storage = 28,000 acre feet.
...ecount rate = 7%.

Benefit Cost Ratio = B/C = 1.03

Net Present Value = B-C = $1.2 M

Notes: Willow Creek - Site 1 Reservoir - Claresholm

Col (2): Reflects a two year construction period and a seven year irrigation development period pro-rated over nine years. At maturity (Year 9) = 142 quarters = 18,720 acres = 7,576 hectares.

Col. (3): Capital cost: $24M; 40% in Year 1 and 60% in Year 2.

Col. (4): Operation and maintenance = 2% x $24M = $480,000/year, beginning in Year 3.

Col. (7): Calculations based on the following tabulations: (acres)

Year	Distance from Creek			CUMULATIVE TOTAL
	0 km	0-0.8 kms	0.8-1.6 kms	
1	-	-	-	-
2	-	-	-	-
3	5,200	1,040	-	6,240
4	-	2,080	-	8,320
5	-	2,080	-	10,400
6	-	1,500	580	12,480
7	-	-	2,080	14,560
8	-	-	2,080	16,640
9	-	-	2,080	18,720
Limit	5,200	6,700		18,720

The respective capital costs are:

Adjacent = nil
0-0.8 km = $128/acre
0.8-1.6 km = $268/acre

Basic data from: Alberta Agriculture/Project Planning Branch, *Irrigation Feasibility in the Willow Creek Basin*, Lethbridge, August 1985.

Col. (8): Calculations based on the following: (cumulative acreage)

Year	Distance from Creek			CUMULATIVE TOTAL
	km	0-0.8 kms	0.8-1.6 kms	
1	-	-	-	-
2	-	-	-	-
3	5,200	1,040	-	6,240
4	5,200	3,120	-	8,320
5	5,200	5,200	-	10,400
6	5,200	6,700	580	12,480
7	5,200	6,700	2,660	14,560
8	5,200	6,700	4,740	16,640
9	5,200	6,700	6,820	18,720

Respective O & M costs are estimated to be the following: ($/acre)

Distance	Operation	Maintenance	TOTAL
Adjacent	-	-	-
0-0.8 km	3.00	1.28	4.28
0.8-1.6 km	5.00	2.68	7.68

Operational costs calculated as an incremental cost vis-a-vis Adjacent lands. Basic data in: Alberta Agriculture, *op. cit.*, p. 8.

Maintenance costs estimated at 1 percent of increment capital costs (vis-a-vis Adjacent lands). Also see: MAA, *Economic and Financial Analysis of Clear Lake Irrigation Development*, Alberta Environment, Edmonton, December 1984, pp. 18-19.

Col. (9): Estimated @ $452/acre. Source: Alberta Agriculture, *op. cit.* Pro-rated according to the incremental acreage under irrigation.

Col. (10): Operational costs estimated @ $23/acre. Source: Alberta Agriculture, *op. cit.* Maintenance costs estimated at 1 percent of incremental capital costs. That is, total O & M = $27.52/acre. Also see: MAA, *op. cit.* Pro-rated according to the cumulative acreage under irrigation.

Col. (11): Summation of Cols. (3)-(10).

Col. (12): Col. (11) discounted using a real rate of interest of 7 percent per annum.

Col. (13): Incremental value added = $59.89/acre. TENTATIVE. As per SSRBPP data, Zone C.

Col. (14): Incremental value added = $76.49/acre. TENTATIVE. As per SSRBPP data, Zone C.

Col. (15): Potential benefits to the Claresholm water supply and related pumping costs. Estimated to amount to $25,000/year, beginning in Year 3.

Col. (16): Assumes value-added spin-offs of 78 percent for the province. I.e., a value-added multiplier of 1.781. Only applicable to Cols. (13)-(14).

Col. (17): Summation of Cols. (13)-(16).

Col. (18): Col. (17) discounted using a real rate of interest of 7 percent per annum.

Table A-2

BASIC ECONOMIC ANALYSIS – WILLOW CREEK – SITE 2 RESERVOIR (PINE COULEE)*

($,000 1989/85)

Year	Irrigated Area		INCREMENTAL COSTS										INCREMENTAL BENEFITS					
			Reservoir		Canal/Other		Delivery		On-Farm		TOTAL		Direct			Indirect	TOTAL	
	Quarters (1)	Acres (2)	Capital (3)	O&M (4)	Capital (5)	O&M (6)	Capital (7)	O&M (8)	Capital (9)	O&M (10)	$'85 (11)	Dis.** (12)	Crops (13)	Livestock (14)	Other (15)	(16)	$'85 (17)	Dis.** (18)
1	–	–	11,800	–	–	–	–	–	–	–	11,800	11,028	–	–	–	–	–	–
2	–	–	17,700	–	–	–	–	–	–	–	17,700	15,459	–	–	–	–	–	–
3	55	7,200	–	590	–	–	256	9	3,254	198	4,307	3,514	431	551	50	767	1,799	1,469
4	73	9,600	–	590	–	–	307	19	1,085	264	2,265	1,728	575	734	50	1,022	2,381	1,816
5	91	12,000	–	590	–	–	321	29	1,085	330	2,355	1,679	719	918	50	1,278	2,965	2,114
6	109	14,400	–	590	–	–	643	48	1,085	396	2,762	1,840	862	1,101	50	1,533	3,546	2,363
7	127	16,800	–	590	–	–	643	66	1,085	462	2,846	1,772	1,006	1,285	50	1,789	4,130	2,572
8	145	19,200	–	590	–	–	643	85	1,085	528	2,931	1,706	1,150	1,469	50	2,045	4,714	2,744
9	164	21,600	–	590	–	–	877	108	1,085	594	3,254	1,770	1,294	1,652	50	2,301	5,297	2,881
10-30	164	21,600	–	590	–	–	–	108	–	594	1,292	7,615	1,294	1,652	50	2,301	5,297	31,218
PRESENT** VALUE											48,113 (c)						47,177 (b)	

* Off-stream reservoir; 40,745 acre feet; effective storage = 32,000 acre feet.

** Discount rate = 7%.

Benefit Cost Ratio = B/C = 0.98

Net Present Value = b-c = ($0.9 M)

Table A-3

BASIC ECONOMIC ANALYSIS - WILLOW CREEK - SITE 3 RESERVOIR (LANE CREEK)*

($,000 1984/85)

Year	Irrigated Area		INCREMENTAL COSTS								INCREMENTAL RECEIPTS						
			Reservoir		Canal/other		Delivery		On-Farm		TOTAL		Direct		Indirect	TOTAL	
	Quarters (1)	Acres (2)	Capital (3)	O&M (4)	Capital (5)	O&M (6)	Capital (7)	O&M (8)	Capital (9)	O&M (10)	$'85 (11)	Dis.** (12)	Crops (13)	Livestock (14)	(15)	$'85 (16)	Dis.** (17)
1	-	-	10,000	-	-	-	-	-	-	-	10,000	9,346	-	-	-	-	-
2	-	-	15,000	-	-	-	-	-	-	-	15,000	13,101	-	-	-	-	-
3	51	6,720	-	500	-	-	195	7	3,039	185	3,926	3,205	402	519	715	1,631	1,331
4	68	8,960	-	500	-	-	287	16	1,012	247	2,062	1,573	537	685	954	2,176	1,660
5	85	11,200	-	500	-	-	287	26	1,012	308	2,133	1,521	671	857	1,193	2,721	1,940
6	102	13,440	-	500	-	-	502	41	1,012	370	2,425	1,616	805	1,028	1,432	3,265	2,175
7	119	15,680	-	500	-	-	600	58	1,012	432	2,602	1,620	1939	1,199	1,670	3,808	2,371
8	136	17,920	-	500	-	-	600	75	1,012	493	2,680	1,560	1,073	1,371	1,909	4,353	2,533
9	153	20,160	-	500	-	-	600	92	1,012	555	2,759	1,501	1,287	1,542	2,147	4,896	2,663
10-30	153	20,160	-	500	-	-	-	92	-	555	1,147	6,760	1,207	1,542	2,147	4,896	28,855

Table A-4

BASIC ECONOMIC ANALYSIS - WILLOW CREEK - SITE 4 RESERVOIR (PINE COULEE/WILLOW CREEK JUNCTION)*
($,000 1984/85)

Year	Irrigated Area		INCREMENTAL COSTS									TOTAL		INCREMENTAL BENEFITS				
			Reservoir		Canal/Other		Delivery		On-Farm		Other			Direct		Indirect	TOTAL	
	Quarters	Acres	Capital	O&M	Capital	O&M	Capital	O&M	Capital	O&M		$'85	Dis.**	Crops	Livestock		$'85	Dis.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(21)	(22)	(23)	(24)		(25)	(26)
1	-	-	18,000	-	-	-	-	-	-	-	1,000	19,000	17,757	-	-	-	-	-
2	-	-	27,000	-	-	-	-	-	-	-	1,000	28,000	24,455	-	-	-	-	-
3	65	8,640	-	900	-	-	440	15	3,905	236	-	5,498	4,488	588	661	975	2,224	1,81
4	87	11,520	-	900	-	-	369	27	1,302	317	-	2,915	2,224	690	881	1,227	2,798	2,13
5	109	14,400	-	900	-	-	719	48	1,302	396	-	3,365	2,399	862	1,101	1,533	3,496	2,49
6	131	17,280	-	900	-	-	772	70	1,302	476	-	3,520	2,345	1,035	1,322	1,841	4,198	2,79
7	153	20,160	-	900	-	-	772	92	1,302	555	-	3,621	2,255	1,207	1,542	2,147	4,896	3,04
8	175	23,040	-	900	-	-	1,265	125	1,302	634	-	4,226	2,460	1,380	1,762	2,454	5,596	3,25
9	189	24,960	-	900	-	-	860	147	868	687	-	3,462	1,883	1,495	1,909	2,659	6063	3,29
10-30	189	24,960	-	900	-	-	-	147	-	687	-	1,734	10,220	1,895	1,909	2,659	6,063	35,73
PRESENT VALUE**												70,486 (:)					54,577 (:)	

* On stream reservoir: 60,000 acre feet. Effective storage = 30,000 acre feet.
** Discount rate = 7%.

Benefit Cost Ratio - B/C = 0.77

Net Present Value - B-C = ($15.9)

POOR
QUALITY
ORIGINAL